Status of the ΔS=1 Hadronic Weak Interaction Program

Report to PAC21 on JLab E99-003

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1. Heavy hypernuclear lifetime measurement

Lifetimes of heavy hypernuclei-decisive for establishing the mass dependence of τ_Λ- have been studied only indirectly. The experimental technique so far applied is the recoil shadow method originally suggested by Metag et al. for the measurement of fission isomers [1]. It has been employed by Noga et al. [2,3], Amstrong et al. [4] and COSY-13 collaboration [5-12] in the hypernuclear lifetime measurements with electrons, antiprotons and protons, respectively. These published lifetimes of heavy hypernuclei are collected in the Table.

2. Kharkov experiment

Kharkov group earlier reported the detection of delayed fission following the interaction of 1.2 GeV electrons with bismuth nuclei [2]. The recoil shadow method was used. Fission fragments were registered by mica detectors as elongated tracks. It was possible to determine both the coordinates and orientation of the tracks in the detector. For each track registered in the shadow area of the detector the trajectory of fission fragment was restored, and the range of the fissile nucleus was determined with 0.5 mm resolution. The range distribution of fissile nuclei obtained at electron energy of 1.2 GeV was exponential in character. The mean range was L = (2.2 ± 0.5) mm which resulted a lifetime about an order of magnitude greater than the lifetime of free Λ, 200 ps. The cross section for the delayed electro-fission was measured to be $(6.5 \pm 1.0)10^{-33}$ cm^2 and the delayed-to-prompt fission cross-section ratio was $(2.5 \pm 1.0)10^{-5}$. Measurement at electron energy of 0.7 GeV revealed no delayed fission. It was considered to be the evidence, which suggests that the delayed fission observed at 1.2 GeV should be associated with hypernuclear decay, except the puzzles from measured long lifetime and an order of magnitude smaller cross section than expected from theoretical estimations [2].

Kharkov group then made repeated measurements [3] using the same recoil-distance technique but with improved spatial distribution detection and resolution in order to make experimental setup sensitive to the lifetime in the range of 200 ps. The obtained range distribution of fissile nuclei was expressed as a sum of two exponential distributions with two mean ranges: L_1 = (0.07 ± 0.02) mm and L_2 = (1.4 ± .5) mm. As a result, two half-lives of Bi hypernuclei with the mean lifetimes $(0.8 \pm .15)10^{-10}$ s and $(1.5 \pm 0.4)10^{-9}$ s were revealed. Neither of the extracted long and short lifetimes was close to the free Λ lifetime (see in attached table).

3. CERN experiment

Such delayed fissions were investigated at CERN using cooled antiprotons beam with beam momentum of 100 MeV/c [4]. The annihilation of antiprotons in the target is accompanied by K^+K^-